Claims

1.An autonomous control program for a small unmanned helicopter wherein the program detects the current position, the attitude angle, the altitude relative to the ground, and the absolute azimuth of the nose of the small unmanned helicopter;

establishes position or velocity reference values from the ground station;

determines optimal control reference values for driving the servo motors that move a number of helicopter rudders from the current position and attitude angle of said small unmanned helicopter detected by said sensors;

based upon said computational processing results, effects translational motion control and tri-axial orientation control on the small unmanned helicopter; or

defines the mathematical model for transfer function representation including pitching operation input and pitch axis attitude angles in the tri-axial orientation control for said small unmanned helicopter as

$$G_\theta(s) = e^{-Ls} \frac{K_\theta \omega_{ns}^2}{(s^2 + 2\varsigma_s \omega_s s + \omega_{ns}^2)(T_\theta s + 1)s} \quad \ldots (13)$$

and based upon said model equations, causes said primary computational unit to calculate optimal control reference values for driving the servo motors.

2.An autonomous control program for a small unmanned helicopter wherein the program detects the current position, the attitude angle, the altitude relative to the ground, and the absolute azimuth of the nose of the small unmanned helicopter;

establishes position or velocity reference values from the ground station;

determines optimal control reference values for driving the servo motors that move a number of helicopter rudders from the current position and attitude angle of said small unmanned helicopter detected by said sensors;

based upon said computational processing results, effects translational motion control and tri-axial orientation control on the small unmanned helicopter; or

defines the mathematical model for a transfer function representation including the rolling input and roll axis attitude angles in the tri-axial orientation control for said small unmanned helicopter as

$$G_\phi(s) = e^{-Ls} \frac{K_\phi \omega_{ns}^2}{(s^2 + 2\varsigma_s \omega_{ns} s + \omega_{ns}^2)(T_\phi s + 1)s} \quad \ldots (14)$$

and based upon said model equations, causes said primary computational unit to calculate optimal control reference values for driving the servo motors.

3.An autonomous control method for a small unmanned helicopter wherein the method detects the current position, the attitude angle, the altitude relative to the ground, and the absolute azimuth of the nose of the small unmanned helicopter;

establishes position or velocity reference values from the ground station;

determines optimal control reference values for driving the servo motors that move a number of helicopter rudders from the current position and attitude angle of said small unmanned helicopter detected by said sensors;

based upon said computational processing results, effects translational motion control and tri-axial orientation control on the small unmanned helicopter; or

defines the mathematical model for transfer function representation including yawing input and yawing axis attitude angles in the tri-axial orientation control for said small unmanned helicopter as

$$G_\psi(s) = e^{-Ls} \frac{K_\psi \omega_{ns}^2}{(s^2 + 2\varsigma_s \omega_{ns} s + \omega_{ns}^2)s} \quad \ldots (15)$$

and based upon said model equations, causes said primary computational unit to calculate optimal control reference values for driving the servo motors.

4.An autonomous control method for a small unmanned helicopter wherein the method detects the current position, the attitude angle, the altitude relative to the ground, and the

absolute azimuth of the nose of the small unmanned helicopter;

establishes position or velocity reference values from the ground station;

determines optimal control reference values for driving the servo motors that move a number of helicopter rudders from the current position and attitude angle of said small unmanned helicopter detected by said sensors;

based upon said computational processing results, effects translational motion control and tri-axial orientation control on the small unmanned helicopter; or

defines the mathematical model for transfer function representation including pitching axis attitude angles and the longitudinal speed in the tri-axial orientation control for said small unmanned helicopter as

$$Vx = g \frac{T}{s+T} \frac{a}{s-a} (-\Theta) \quad \ldots (16)$$

and based upon said model equations, causes said primary computational unit to calculate optimal control reference values for driving the servo motors.

5.An autonomous control method for a small unmanned helicopter wherein the method

detects the current position, the attitude angle, the altitude relative to the ground, and the absolute azimuth of the nose of a small unmanned helicopter;

establishes position or velocity reference values from the ground station;

determines optimal control reference values for driving the servo motors that move a number of helicopter rudders from the current position and attitude angle of said small unmanned helicopter detected by said sensors;

based upon said computational processing results, effects translational motion control and tri-axial orientation control on the small unmanned helicopter; or

defines the mathematical model for transfer function representation including rolling axis attitude angles and the lateral speed in the translational motion control for said small unmanned helicopter as

$$Vy = g \frac{T}{s+T} \frac{a}{s-a} \Phi$$

$$\cdots (17)$$

and based upon said model equations, causes said primary computational unit to calculate optimal control reference values for driving the servo motors.

6.An autonomous control method for a small unmanned helicopter wherein the method detects the current position, the attitude angle, the altitude relative to the ground, and the absolute azimuth of the nose of the small unmanned helicopter;

establishes position or velocity reference values from the ground station;

determines optimal control reference values for driving the servo motors that move a number of helicopter rudders from the current position and attitude angle of said small unmanned helicopter detected by said sensors;

based upon said computational processing results, effects translational motion control and tri-axial orientation control on the small unmanned helicopter; or

defines the mathematical model for transfer function representation of the vertical speed in the translational motion control for said small unmanned helicopter as

$$Vz = \frac{k}{s} \Theta ,$$

$$\cdots (18)$$

and based upon said model equations, causes said primary computational unit to calculate optimal control reference values for driving the servo motors.

7. The autonomous control method for a small unmanned helicopter of Claim 1, wherein, in determining optimal control reference values for driving the servo motors that drive the rudders for the small unmanned helicopter, said primary computational unit for said autonomous control system autonomously controls said small unmanned helicopter by executing independent autonomous control algorithms on the six physical quantities of said small unmanned helicopter: pitch axis attitude angle, roll axis attitude angle, yaw axis

attitude angle, longitudinal speed, lateral speed, and vertical speed.

8. The autonomous control method for a small unmanned helicopter of Claim 1, wherein said small unmanned helicopter is autonomously controlled by constructing the respective autonomous control algorithms as a type 1 servo system so that for the respective physical quantities of said small unmanned helicopter, the steady-state deviation from any reference value will be zero.

9. The autonomous control method for a small unmanned helicopter of Claim 7, wherein said small unmanned helicopter is autonomously controlled by applying either the linear quadratic Gaussian (LQG) theory or the linear quadratic integral (LQI) theory to the autonomous control algorithms that are constituted as a type 1 servo system, by treating the respective autonomous control algorithms as uncoupled transfer function representation mathematical models.

10.The autonomous control method for a small unmanned helicopter of Claim 1, wherein, in determining optimal control reference values for driving the servo motors that drive the rudders for the small unmanned helicopter, dynamic characteristics consisting of longitudinal speeds and lateral speeds are represented as mathematical models for which pitch axis attitude angles and roll axis attitude angles are input quantities, and said small unmanned helicopter is controlled autonomously by calculating the respective attitude angles that are necessary for effecting arbitrary longitudinal and lateral speeds.

11. The autonomous control method for a small unmanned helicopter of Claim 1, wherein, in determining optimal control reference values for driving the servo motors that drive the rudders for the small unmanned helicopter, in order to move said small unmanned helicopter to an arbitrary position, longitudinal, lateral, and vertical speed reference values are defined as follows:

$$Vxref = \alpha(Pxref - Px)$$

$$\cdots (19)$$

for a longitudinal reference value,

$$Vyref = \alpha(Pyref - Py)$$

$$\cdots (20)$$

for a lateral value, and

$$Vzref = \beta(Pzref - Pz)$$

$$\cdots (21)$$

for a vertical reference value,

thereby effecting the autonomous control of said small unmanned helicopter.

12.The small unmanned helicopter autonomous control method of Claim 1, wherein, in determining optimal control reference values for driving the servo motors that drive the rudders for the small unmanned helicopter, and further, the transfer function representation mathematical model including the rolling force and rolling axis attitude angles in the tri-axial orientation control for said small unmanned helicopter is defined as

$$G_\phi(s) = e^{-Ls} \frac{K_\phi \omega_{ns}^2}{(s^2 + 2\varsigma_s \omega_{ns} s + \omega_{ns}^2)(T_\phi s + 1)s}$$

$$\cdots (22)$$

and said small unmanned helicopter is autonomously controlled based on said mathematical model.

13.The small unmanned helicopter autonomous control algorithm of Claim 1, wherein, in determining optimal control reference values for driving the servo motors that drive the rudders for the small unmanned helicopter, and further, the transfer function representation mathematical model including the yawing force and yawing axis attitude angles in the tri-axial orientation control for said small unmanned helicopter is defined as

$$G_{\psi}(s) = e^{-Ls} \frac{K_{\psi}\omega_{ns}^{2}}{(s^{2} + 2\varsigma_{s}\omega_{ns}s + \omega_{ns}^{2})s}$$

$\cdots$ (23)

and said small unmanned helicopter is autonomously controlled based on said mathematical model.

14.The small unmanned helicopter autonomous control method of Claim 1, wherein, in determining optimal control reference values for driving the servo motors that drive the rudders for the small unmanned helicopter, and further, the transfer function representation mathematical model including the pitching axis attitude angle and the longitudinal speed in the tri-axial orientation control for said small unmanned helicopter is defined as

$$Vx = g\frac{T}{s+T}\frac{a}{s-a}(-\Theta)$$

$\cdots$ (24)

and said small unmanned helicopter is autonomously controlled based on said mathematical model.

15.The small unmanned helicopter autonomous control method of Claim 1, wherein, in determining optimal control reference values for driving the servo motors that drive the rudders for the small unmanned helicopter, and further, the transfer function representation mathematical model including the rolling axis attitude angle and the lateral speed in the translational motion control for said small unmanned helicopter is defined as

$$Vy = g\frac{T}{s+T}\frac{a}{s-a}\Phi$$

$\cdots$ (25)

and said small unmanned helicopter is autonomously controlled based on said mathematical model.

16.The small unmanned helicopter autonomous control method of Claim 1, wherein, in determining optimal control reference values for driving the servo motors that drive the rudders for the small unmanned helicopter, and further, the transfer function representation mathematical model for the vertical speed in the translational motion control for said small unmanned helicopter is defined as

$$Vz = \frac{k}{s}\Theta_t \quad \cdots (26)$$

and said small unmanned helicopter is autonomously controlled based on said mathematical model.

17.The autonomous control method for a small unmanned helicopter of Claim 1, wherein, in determining optimal control reference values for driving the servo motors that drive the rudders for the small unmanned helicopter, the transfer function representation mathematical model that describes the dynamic characteristics of said servo motors included in said Eqs. 13 and 14 is defined as

$$G_s(s) = \frac{\omega_{ns}^2}{(s^2 + 2\varsigma_s\omega_{ns}s + \omega_{ns}^2)} \quad \cdots (27)$$

wherein an autonomous control algorithm is designed by entering M-series signals (pseudo-white signals) into said servo motors, by applying a partial space identification method based on input/output relationships, by determining the unknown parameters ω_{ns} and $\zeta_s$in Eq. 15, and by using the resulting values, thereby autonomously controlling said small unmanned helicopter.

18.The autonomous control method for a small unmanned helicopter of Claim 1 wherein, in determining optimal control reference values for driving the servo motors that drive the

rudders for the small unmanned helicopter, the parameters that are included in said Eqs. 13 through 18, specifically, parameters K_θ, and T_θ, contained in Eq. 13; parameters K_φ, and T_φ, contained in Eq. 14; parameters K_ψ and T_ψ contained in Eq. 15; parameters T and a contained in Eq. 17; and parameter k contained in Eq. 18 are adjusted so that their experimental results and simulation results will agree, autonomous control algorithms are designed according to the resulting values, and said small unmanned helicopter is thereby autonomously controlled.

19.A small unmanned helicopter autonomous control method wherein, in determining optimal control reference values for driving the servo motors that drive the rudders for the small unmanned helicopter, sine wave signals representing arbitrary frequency, amplitude, and time values are entered into said servo motors by manual operation, and during this process, said sine wave signals are obtained by using a function that outputs manual operation signals that are input into said servo pulse mixing/switching unit of a servo pulse mixing/switching unit that is an external device to said autonomous control system; wherein, simultaneously, the flight status of said small unmanned helicopter is obtained by means of said sensors for said autonomous control system, and wherein the parameters contained in Eqs. 13 through 18 in Claim 1 are determined by analyzing the interrelationship between the various pieces of data thus obtained, and wherein autonomous control algorithms are created based on the mathematical models thus obtained.